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Saturated Zone Denitrification at California Dairies

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Denitrification can effectively mitigate the problem of high nitrate concentrations in groundwater under dairy operations by reducing nitrate to N_2 gas, at sites where biogeochemical conditions are favorable. We present results from field studies at central California dairies that document the occurrence of saturated-zone denitrification in shallow groundwater using biomolecular indicators, stable isotope compositions of nitrate, and measurements of dissolved excess N_2 gas. Excess N_2 concentrations provide a measure of the extent to which nitrate in groundwater has been partially or completely denitrified. Abundant excess N_2 and young $^3H/^3He$ apparent groundwater ages indicate high denitrification rates near manure lagoons where multiple lines of evidence indicate seepage of lagoon water into the groundwater system. Natural tracers of lagoon water include high chloride and dissolved organic carbon concentrations, distinctive trace organic compounds, and high groundwater $\delta^{18}O$ values (relative to other recharge sources). Proximal to the lagoons, NH_4^+ may be present in groundwater, but is strongly adsorbed on to sediment particles. Bubble formation in the lagoons causes the exsolution of other gases (N_2, Ar, Ne, He, etc.), which partition into the gas phase and strip the lagoon water of its dissolved gas load, providing a unique tracer of lagoon seepage in groundwater.

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